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(54) Abstract Title
Vortex-induced vibration suppression

(57) A hollow, cylindrical, vortex-induced vibration suppression unit 10 comprises separable sections 2, 3 which can be locked together to form said unit 10 to fit around a marine installation such as a riser (not shown). Around the body of the unit 10 is formed a V-shaped helical groove 6. In another embodiment, the unit has more than one helical groove. A series of units 10 may be joined together end-to-end to form a device as required for the installation.

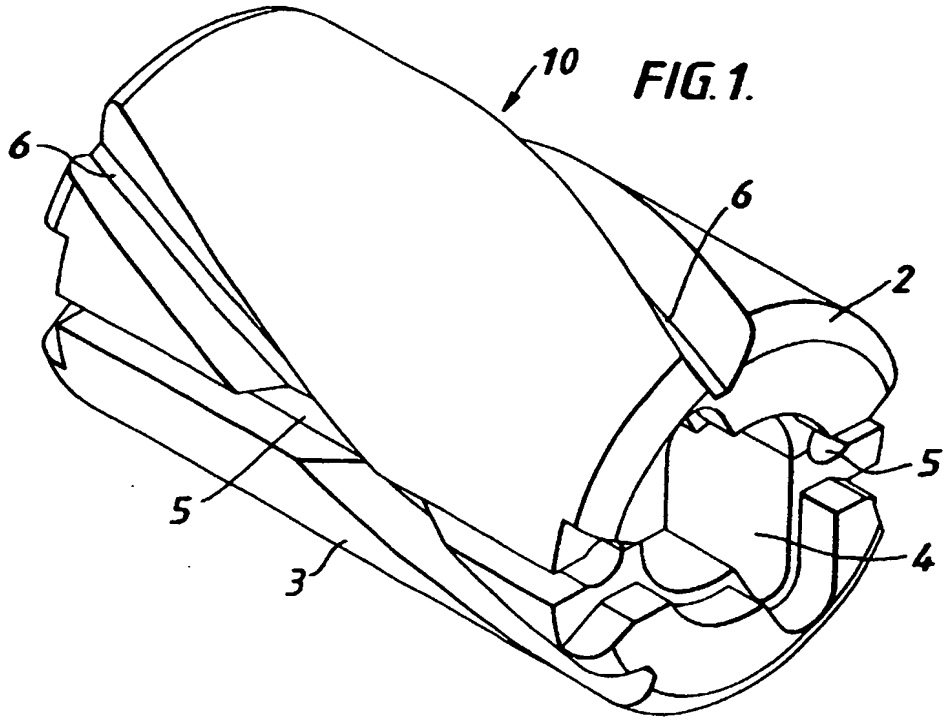

FIG. 1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

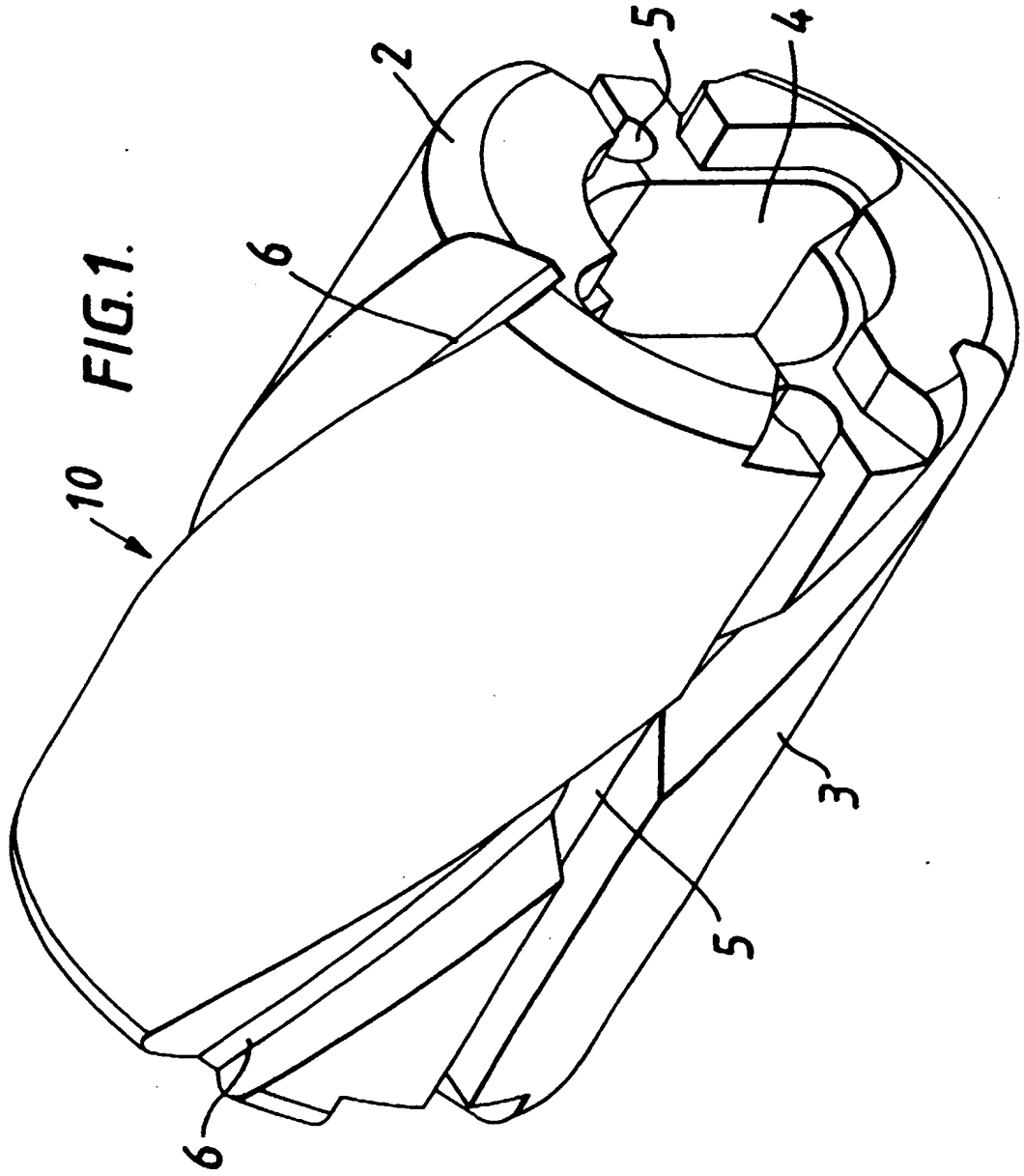


FIG.1.

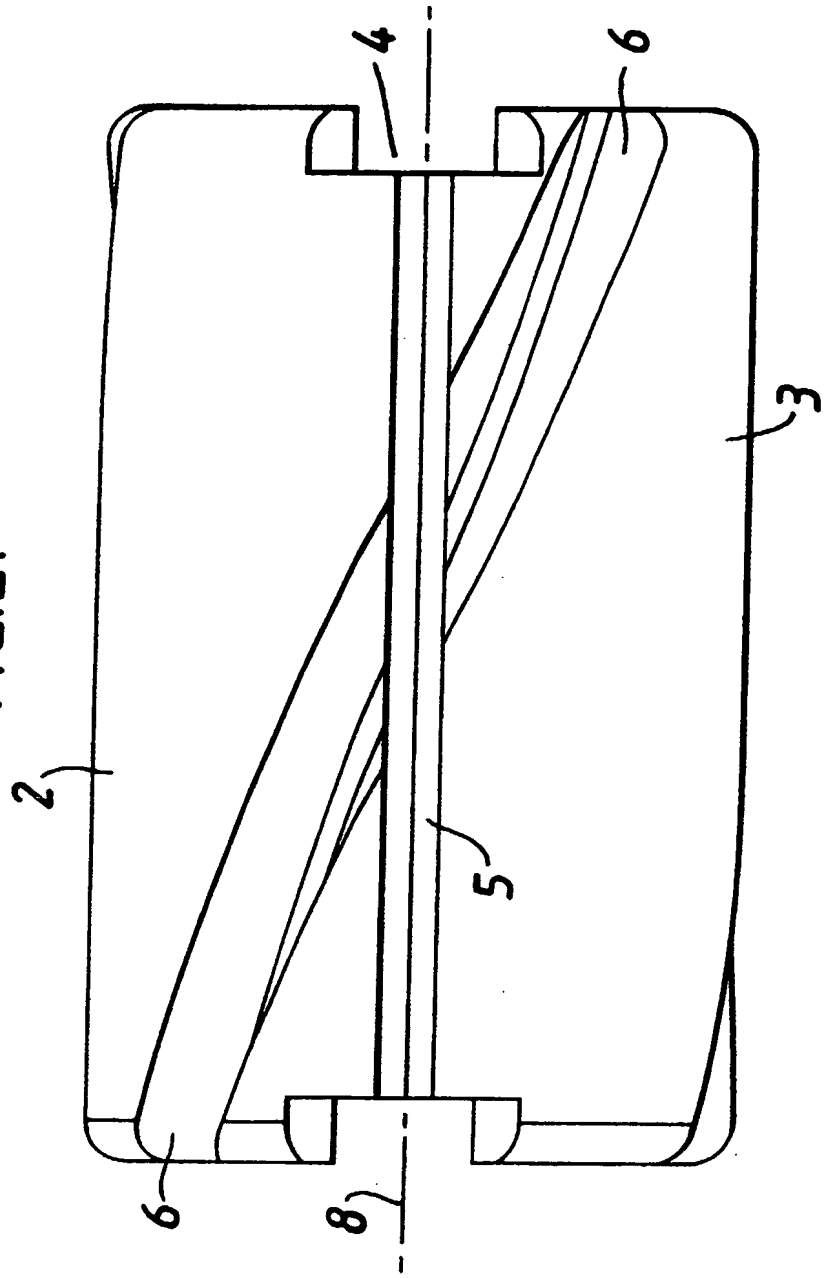
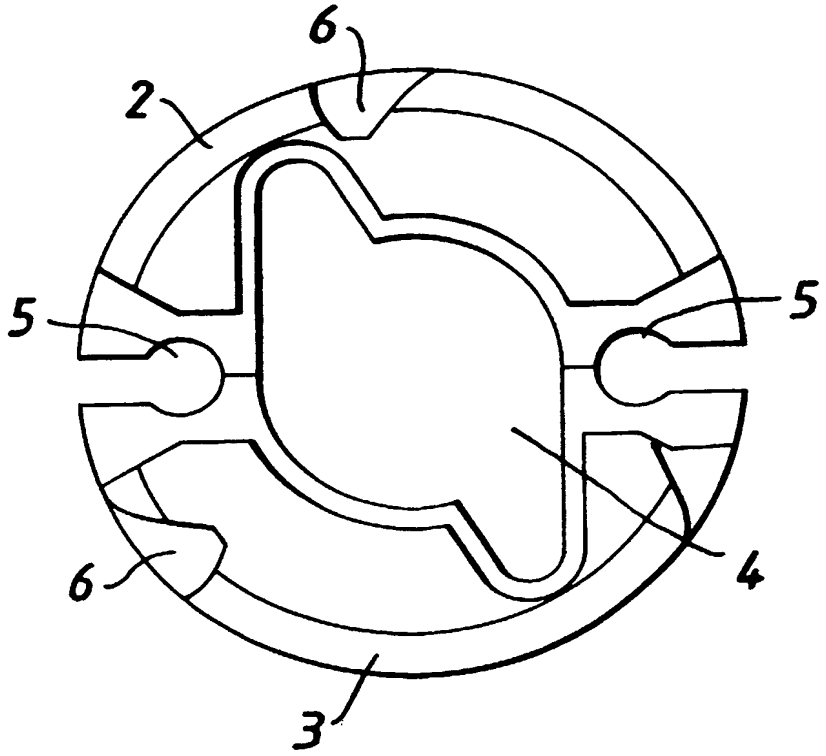


FIG.2.

FIG. 3.



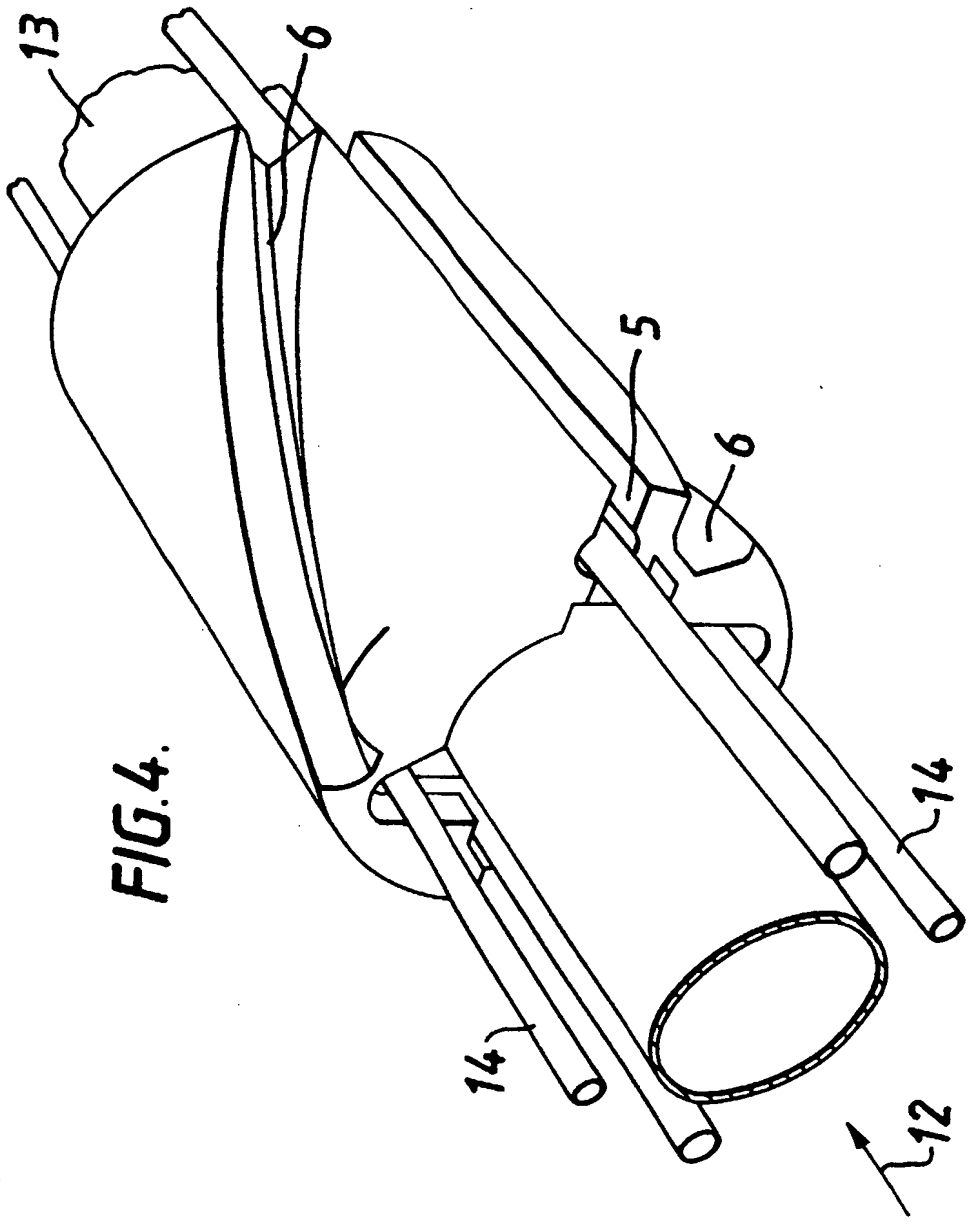


FIG.4.

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Vortex-Induced Vibration Suppression

The present invention is concerned with vortex-induced vibration suppression, particularly in marine environments and primarily but not exclusively, for undressed rigid sub-sea drilling risers.

Exploration drilling is increasingly taking place in areas of high ocean currents. When any fluid moves past a tubular body at a velocity above a critical level, vortices are developed alongside and shed behind the tubular body. When the rate of vortex shedding approaches the natural resonance frequency of the tubular body a sympathetic vibration or resonance is excited in the tubular body, this vibration may lead to fatigue problems in the tubular body. Where multiple tubular bodies are in close proximity, in an "undressed" or "bare" drilling riser assembly, and they are exposed to ocean currents, vortex-induced vibration problems in downstream tubular bodies may be amplified. Furthermore, the presence of adjacent tubular bodies may cause significant increases in drag forces acting on the individual tubular bodies.

Suppression of vortex-induced vibration greatly reduces, if not eliminates, the risk of fatigue of the undressed riser tubular bodies.

For single tubular risers, the standard vortex-induced vibration suppression device is the "Helical Strake." This is one or more outwardly projecting triangular profiles, which are mounted on, and spiral down the tubular body. For arrangement of multiple tubular bodies in relatively close proximity (such as the marine drilling riser) the effectiveness of standard vortex-induced vibration suppression devices such as strakes

is known to be substantially reduced and in addition the lateral movement of the undressed drilling riser during its passage through the narrow clearances of the drilling floor rotary table is likely to result in major damage to conventional helical strake systems.

An object of the invention is to provide versatile units and devices capable of being attached to all configurations of marine objects or installations.

A further object is to provide vortex-induced vibration suppression for all of the tubular bodies in a drilling riser assembly irrespective of the proximity of other tubular bodies and which can readily tolerate passage through the rotary table without significant damage.

According to one aspect of the present invention there is provided a unit for use in suppressing vortex-induced vibration of a marine object or installation in a sub-sea environment, said unit being of cylindrical form designed to fit around the marine object or installation and having at least one helical relief groove in its outer surface. Where the object to be protected is a tubular body such as a drilling riser a series or string of such units would be mounted end-to-end to form a unitary device where the helical relief groove or grooves run continuously along the string.

Such a device can shield and protects the individual tubular bodies of the previously undressed riser assembly from the effects of vortex-induced vibration. Since the helical groove is wholly within the outer surface of the units rather than protruding damage can be avoided during contact with the rotary table. The units may be rapidly

manufactured by mass production techniques such as rotational, blow or injection moulding and can be configured internally to match all configurations of riser assembly. The vortex-induced vibration suppression performance may be adjusted through modifications to the arrangement and design of the helical groove or grooves. Further the units of the device can be neutrally buoyant and has minimal weight out of the water. The former feature ensures no inference with design submerged weight distribution down the riser string, whilst the latter feature maximises the quantity of riser, which can be carried by the drilling vessel.

In another aspect the invention provides a vortex-induced vibration suppressor adapted to fit around an object subjected to environmental vortices and characterized in that the suppressor presents to the environment a smooth curvilinear outer surface remote from the object which surface has relief discontinuities therein desgined to suppress the vortices.

In another aspect the invention provides a method of suppressing vortex-induced vibration of an underwater object particularly such an object with one or more tubular bodies, the method comprising the steps of:

providing a plurality of hollow protective units each with a relieved outer surface profile capable of inherently reducing vortex-induced vibration; and

securing the units around the object.

The invention may be understood more readily, and various other features of the invention may become apparent, from consideration of the following description.

An embodiment of the invention will now be described, by way of examples only, with reference to the accompanying drawings, wherein:

Figure 1 is a perspective view of one unit of a device constructed in accordance with the invention;

Figure 2 is a side view of the unit shown in Figure 1;

Figure 3 is an end view of the unit shown in Figure 1 and

Figure 4 is a perspective view of the unit shown in Figures 1 to 3 when attached to a typical marine installation.

As shown in Figures 1 to 3, a unit 10 is of elongate cylindrical form and is composed of two complementary sections 2, 3 joined together and separable from one another along a central axial plane 8.

The sections 2, 3 collectively define an internal cavity 4 with a shape determined by the marine object on which the unit 10 is to be fitted. In its simplest form the cavity 4 is defined by an inner bore surface of circular cross-section designed to mate with a tubular sub-sea riser. The sections 2, 3 collectively define an outer surface which is relieved with grooves 6 which have a helical configuration along the unit 10. In this embodiment the grooves 6 have a V-shaped profile but this is not essential. Normally a series of such units 10 would be arranged end-to-end to provide a device constructed in accordance with the invention. The sections 2, 3 of each unit 10 may be held

together in a variety of ways. For example, flexible bands (not shown) can be wrapped around the sections 2, 3 or the sections 2, 3 can be shaped to lock together. Figure 4 shows one of the units 10 surrounding a sub-sea installation 12 composed of a central tubular core riser 13 and four additional pipes 14. To accommodate the pipes 14 the internal cavity 4 is extended through the unit 10 to a pair of diametrically-opposed grooves 5 which extend longitudinally and parallel to the axis of the unit 10. The units 10 preferably slidable fit on the installation 12 and are held coupled to one another at the ends. To prevent the units 10 from moving axially a string of the units 10 may abut on thrust collars (not shown) located adjacent to a flange 5 at the end of each riser joint. The helical relief grooves 6 protect the installation 12 against vortex-induced vibration.

The number of helical grooves 6 per 360° is preferably in the range of 1 to 4 and the typical pitch of each helix is preferably in a range 5 to 25 times the outside diameter of the unit 10. The depth of each groove 6 is preferably 0.05 to 0.20 times the outside diameter of the unit 10.

The sections 2, 3 making up the unit 10 are typically fabricated from a thermoplastic polyethylene, however alternative material such as thermosetting resin composites and thermoplastic composites may be used especially such composites with suitable high performance quality for use in marine applications.

The wall thickness of the sections 2, 3 of the unit 10 is selected to achieve the necessary stiffness to accommodate and resist the dynamic loads created in the sub-sea environment. Each unit has a typical overall length of 1 to 4 metres.

CLAIMS

1. A unit for use in suppressing vortex-induced vibration of a marine object or installation in a sub-sea environment, said unit being of cylindrical form designed to fit around the marine object or installation and having at least one helical relief groove in its outer surface.

2. A unit according to claim 1 and composed of several sections which can be separated from one another or brought together to surround and contact the marine object or installation.

3. A unit according to claim 1 or 2, wherein there are several helical grooves in the outer surface.

4. A unit according to claim 1, 2 or 3, wherein the or each helical groove is of V-shaped profile.

5. A unit according to any one or more of claims 1 to 4, wherein the pitch of the or each groove is in the range 5 to 25 times the outer diameter of the unit.

6. A unit according to any one or more of the preceding claims, wherein the maximum depth of the or each groove is in the range 0.05 to 0.20 times the outer diameter of the unit.

7. A unit according to any one or more of the preceding claims and made of polyethylene.

8. A device for use in suppressing vortex-induced vibration of a marine object or installation in a sub-sea environment, said device comprising a series of units according to any one or more of the preceding claims.

9. A device according to claim 8, wherein the units are joined together at adjacent ends.

10. A device for suppression of vortex-induced vibration or a unit therefor substantially as described, and as illustrated in, any one or more of the Figures of the accompanying drawings.

11. A marine object or installation such as a sub-sea riser when protected against vortex-induced vibration by a unit or device according to any one of the preceding claims.

12. A method of suppressing vortex-induced vibration of an underwater object particularly such an object with one or more tubular bodies, the method comprising the steps of:

providing a plurality of hollow protective units each with a relieved outer surface profile capable of inherently reducing vortex-induced vibration; and

securing the units around the object.

13. A method according to claim 12, wherein each protective unit is made up of one or more complementary sections and the sections are installed around the object in situ.

14. A method according to claim 12 or 13, wherein the relieved outer surface is provided by one or more helical grooves.

15. A method according to claim 14, wherein the or each helical groove runs continuously through a string of adjacent units disposed end-to-end.

16. A method according to claim 14 or 15 when appended to claim 13, wherein each complementary section of each unit has a part helical relief groove on its exterior surface.

17. A method according to any one of claims 12 to 16, wherein each unit is slidably fitted on the object and restrained from significant axial movement by thrust collars of the object.

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Application No: GB 0120565.7 9
Claims searched: 1 to 11

Examiner: Matthew Perkins
Date of search: 28 January 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): E1F FAC, FAC1; E1H HGG; F2P; F2R RD, RR, RX, RZ

Int Cl (Ed.7): E02D; E21B; F15D F16L

Other: Online: WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2288198 A	(HYDRIL CO) See abstract & figures	1, 2, 3 & 7
X	EP 0277433 A	(FINUIK SA) See abstract, figures and paragraph beginning "Le dispositif..."	1, 2, 3, 7, 8 & 9
A	GB 2363363 A	(SHELL INTERNATIONALE) See abstract and figures	-
A	GB 2362444 A	(CRP GROUP) See abstract and figures	-
A	GB 2335248 A	(CRP GROUP) See abstract and figures	-
A	GB 2315797 A	(CORROSION CONTROL INTERNATIONAL) See abstract and figures	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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